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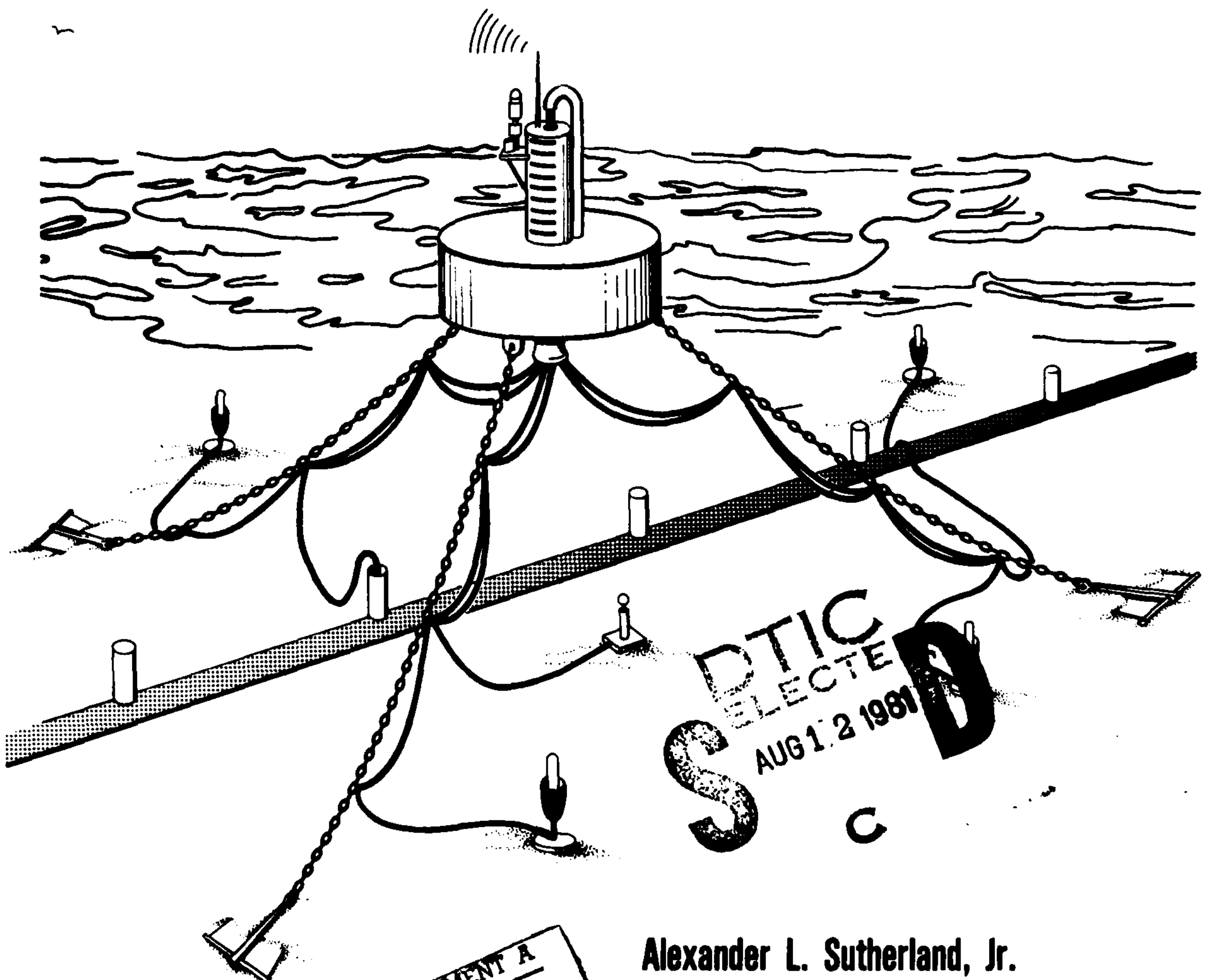
NSTL Station, Mississippi 39529

NORDA Technical Note 94

Brine Measurement System (BRIMS)
Section II: Implant Plan



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Ocean Technology Division
Ocean Science and Technology Laboratory

JUNE 1981

FOREWORD

This report presents an operations plan detailing the installation of the offshore portion of the Brine Measurement System (BRIMS). This installation occurred during the period September through October 1979.

The report is Section II of a three-section series. Section I describes the BRIMS design, and Section III details BRIMS operation and maintenance.

Some of the original implantment concepts, in particular, cable-laying procedures and underwater sensor mounting configurations, changed significantly throughout the nearly two-year period in which NORDA maintained and developed the BRIMS after initial implantment. The reader is referred to Section III of this set for final cable-laying procedures and sensor mounting configurations.

Richard C. Swenson
Head, Ocean Technology Division
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ABSTRACT

The Brine Measurement System (BRIMS) was designed and developed by the Naval Ocean Research and Development Activity (NORDA), Code 350, in support of the Department of Energy, Strategic Petroleum Reserve's requirement to expel brine from a salt dome for subsequent oil storage. BRIMS consists of a buoyed platform which telemeters, to shore, data gathered by an array of oceanographic and meteorological sensors that measure and quantify the dispersion of the brine solution emanating from a pipeline ending 12.5 nautical miles at sea in the Gulf of Mexico.

The BRIMS buoy and mooring spread consists of a 10.5 ton cylindrical buoy and three chain/anchor mooring legs, each consisting of 13.5 tons of hardware. Emanating from the buoy are a series of cables which transmit data from underwater sensors.

This report details the operational planning necessary to effectively and efficiently implant a system of this magnitude and complexity.

ACKNOWLEDGEMENT

The U.S. Coast Guard Cutter BLACKTHORN was the implantment vessel for the BRIMS buoy and mooring system. The hard work, dedication, and good seamanship exhibited by the officers and the crew of BLACKTHORN contributed significantly to the success of this operation.

Three months after the BRIMS implantment, BLACKTHORN suffered a collision at sea and sank, with a loss of twenty-three lives.

The author wishes to express his sympathy to the families, friends, and shipmates who were affected by this tragic loss.

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1.0 INTRODUCTION

1.1 BACKGROUND

Salt mounds, located along the Gulf of Mexico in the states of Texas and Louisiana, could, if evacuated of their salt content, form extensive, natural cavities for use as fuel storage containers. The stored fuel could then be used during periods of reduced imported fuel from foreign sources. A brine solution, originally contained in the mounds, would be pumped out of these mounds and deposited, via pipeline and diffuser, into the Gulf of Mexico.

The Department of Energy (DOE) has been tasked with the implementation of this concept. DOE, in turn, has funded the National Oceanic and Atmospheric Administration (NOAA) to assess the total ecosystem impact on receiving waters and biota resulting from the discharge of these saturated brine solutions.

NOAA has requested the services of the Naval Ocean Research and Development Activity (NORDA) to develop a system which can provide real-time display, onshore, of salinity, temperature, current, and brine flow at or near the diffuser. This real-time monitoring system, dubbed BRIMS (short for Brine Measurement System), is a significant component of the overall environmental assessment program.

The BRIMS configuration, shown in the artist's concept of Figure 1, consists of a three-point moored buoy which is anchored over the pipeline diffuser. Bottom-mounted sensors (salinity, temperature, current, and flow) transmit their data through cables to the buoy. These data are then telemetered back to shore.

1.2 SCOPE

This report details the BRIMS buoy, cable, and sensor implantment plan.

1.3 LOCATION

1.3.1 General

The buoy will be implanted at a point approximately 15 miles south of the entrance to Freeport Harbor, Freeport, Texas.

The general area location is shown in Figure 2. NOS Chart 11321 (not included) encompasses the site location.

1.3.2 Specific

The buoy will be located 100 ft to the west of the 15th diffuser port (counting out from shore) on the brine line, see Figure 3. The 15th port is located at 28°44'18.606"N, 95°14'39.742"W. The port is marked by both a surface and a subsurface buoy.

Depth at the site is approximately 69 ft. Water visibility at the bottom has been reported to be as high as 30 ft during periods of good weather.

An exploded scale (1 inch = 200 ft) special LORAN-C (not included) has been specially constructed to cover the area of the BRIMS buoy and sensors.

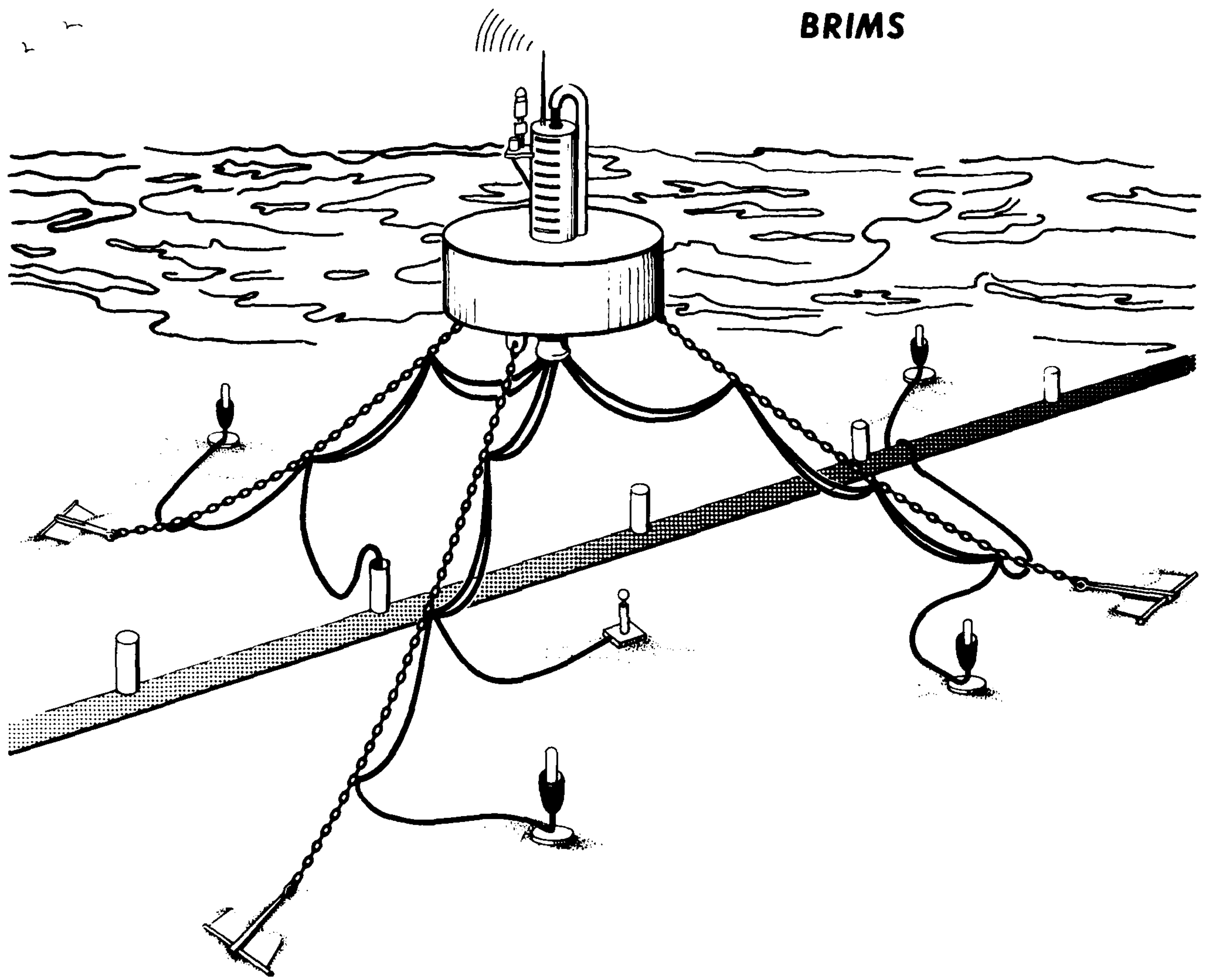

Figure 1. Brine Measurement System

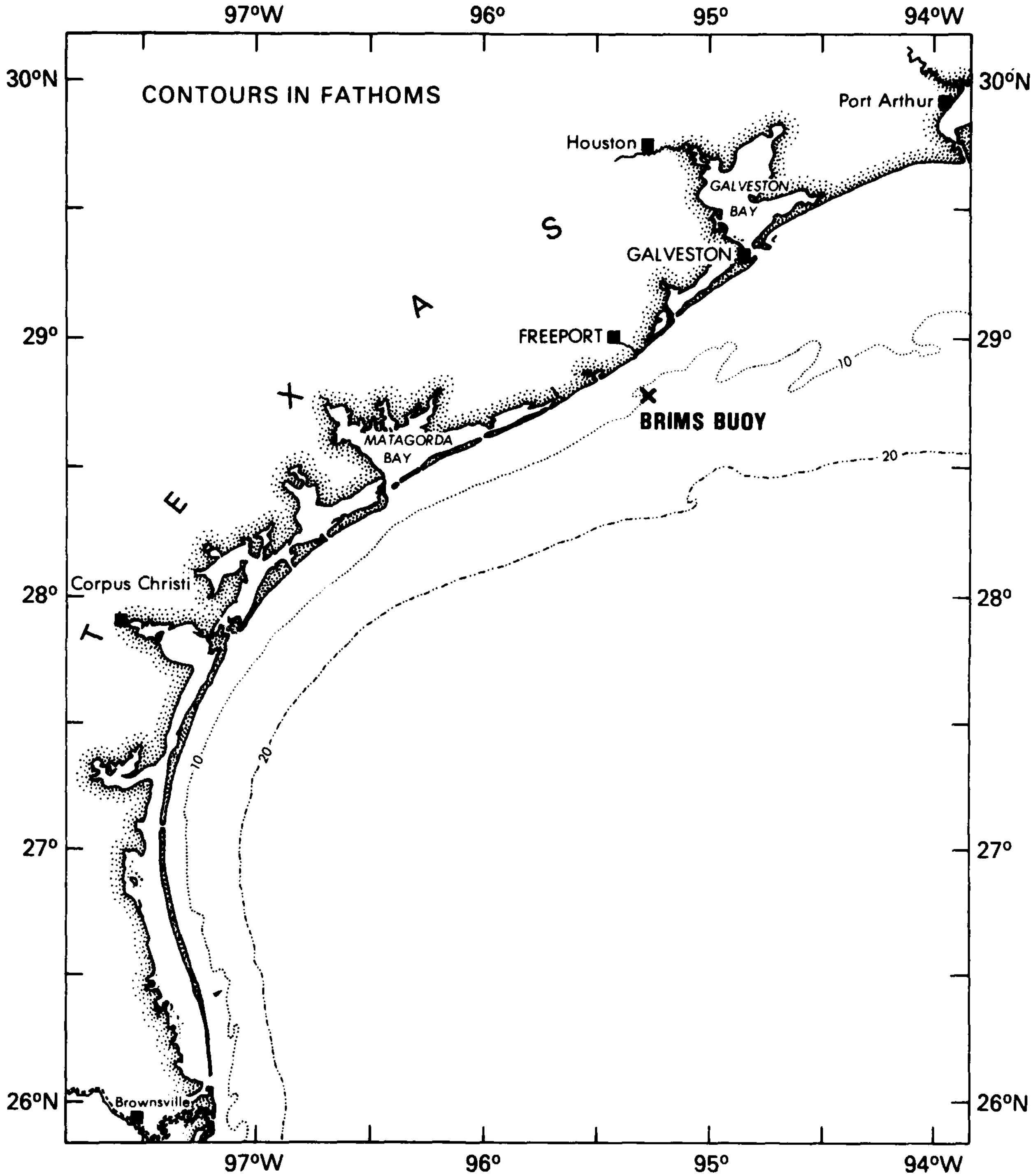

Figure 2. BRIMS General Location

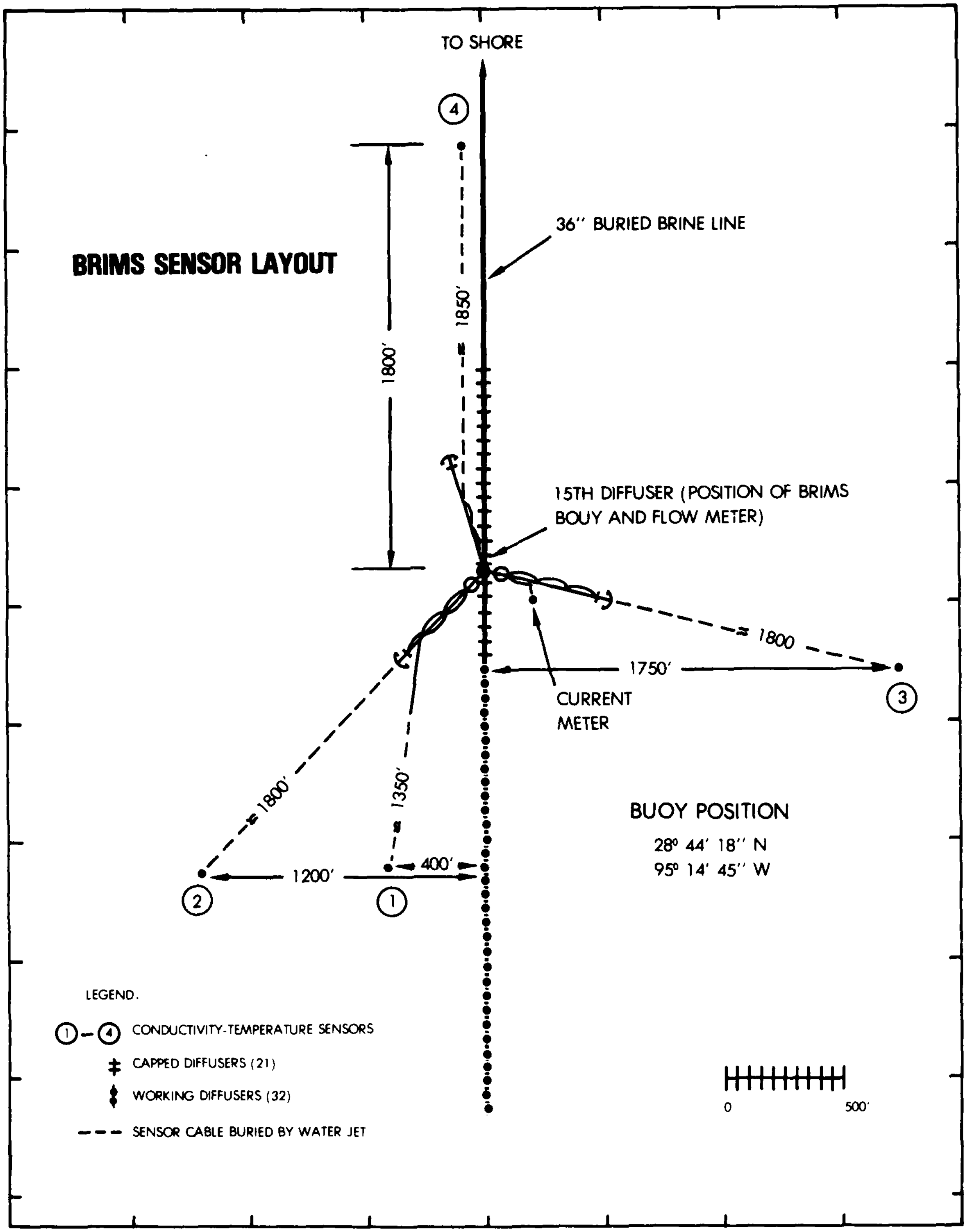

Figure 3. BRIMS Sensor Layout

1.4 PARTICIPATING ORGANIZATIONS

The participating organizations and points of contacts are listed below.

ORGANIZATION	FUNCTION	CONTACT
Naval Ocean Research and Development Activity (NORDA)	Projection Direction, Design, Equipment, Coordination	A. Sutherland R. Rumpf (Comm.) 601-688-4742 (FTS--Direct) 494-4742
U. S. Coast Guard Cutter BLACKTHORN	Buoy Installation Vessel	LCDR Jim Sepel (C.O.) (Comm.) 713-763-2230 (FTS--Direct) 527-6146
Schaeffer Diving Company	Diving/Cable Laying	Louis Schaeffer (Comm.) 713-233-6356 (FTS--Area) 729-4011
U. S. Coast Guard Group Galveston	BLACKTHORN Home Base Logistics/Staging	Capt. Reed (C.O.) (Comm.) 713-763-1635 (FTS--Direct) 527-6671
U. S. Coast Guard Station Freeport	Transportation to/from Buoy	BM-1 Fiel (Comm.) 713-233-3801 (FTS--Area) 729-4011
NAVOCEANO (Shipping)	Shipping from NSTL	Richard Shaver (Comm.) 601-688-4335 (FTS--Direct) 494-4385
Port of Galveston	Receiving Buoy	L. B. Prino (Comm.) 713-765-9324 (FTS--Area) 527-6211
Dept. of Energy Bryan Mound (DOE/BM)	User, Logistics	Neil Packard (Comm.) 713-223-5406 (FTS--Direct) 527-5406
Dept. of Energy New Orleans (DOE/NO)	Coordination, Diving Contract Administration	Skip Mills (Comm.) 504-838-0297 (FTS--Direct) 680-0297
National Oceanic and Atmospheric Administration (NOAA)	Funding and Scientific Direction to Norda	Ed Ridley C. Burroughs (Comm.) 202-634-7381 (FTS--Direct) 634-7381

1.5 PHILOSOPHY

Implant techniques are geared to the typical method of Coast Guard buoy implantment, i.e., free running of all chain and anchors. Each leg of the mooring can be installed as a separate operation; thus, the operation may be interrupted at frequent points to allow for weather interruptions or re-rigging for more efficient deployment.

Diving operations will be conducted to commercial (OSHA) standards. No experimental or untried equipment will be utilized.

Safety will be of paramount importance. The Senior NORDA Representative or any participating organization supervisor may stop the job at any time if a safety hazard exists. The job will not continue until all hazardous conditions have been corrected.

1.6 CONTROL

Coordination and technical direction of all phases of the implant operation will be the responsibility of the Senior NORDA Representative.

Operational supervision and direction of the buoy and mooring implantment will be the responsibility of the Commanding Officer USCGC BLACKTHORN.

Operational supervision and direction of all diving and cable-laying operations will be the responsibility of the assigned contractor field supervisor.

2.0 MOOR DESCRIPTION

2.1 DESIGN CRITERIA

The mooring configuration selected is that of a Navy class-D telephone moor. This configuration consists of a three-point moor capable of safely withstanding a lateral load of 75,000 lbs in any direction. The buoy itself is designed to accept cables coming up from the sea floor through a central hawse pipe. Typically, for Navy fleet mooring purposes, the moor is used to moor ships at remote anchorages and provide them, via the hawse pipe, a cable to a shore-based telephone line. Consequently, the moor is ideal for accepting the BRIMS sensor cables.

The moor will have a watch circle of less than 35 ft in diameter.

The buoy has a capability of rising 50 ft above the still water level. Maximum predicted wave heights in the area are not expected to exceed 37 ft above the still water level.

The Navy has considerable precedence in the longevity of this type moor in open sea environments.

The entire moor weighs 106,000 lbs in air.

2.2 COMPONENT DESCRIPTION--ASSEMBLY DIAGRAM

2.2.1 Buoy

The buoy is shown in Figure 4. The base of the buoy measures 7 ft in height by 14 ft in diameter. Shipping diameter is 17 ft. The top house of the buoy is 11'5" high. Weight of the buoy is 21,000 lbs. The house weighs approximately 1500 lbs.

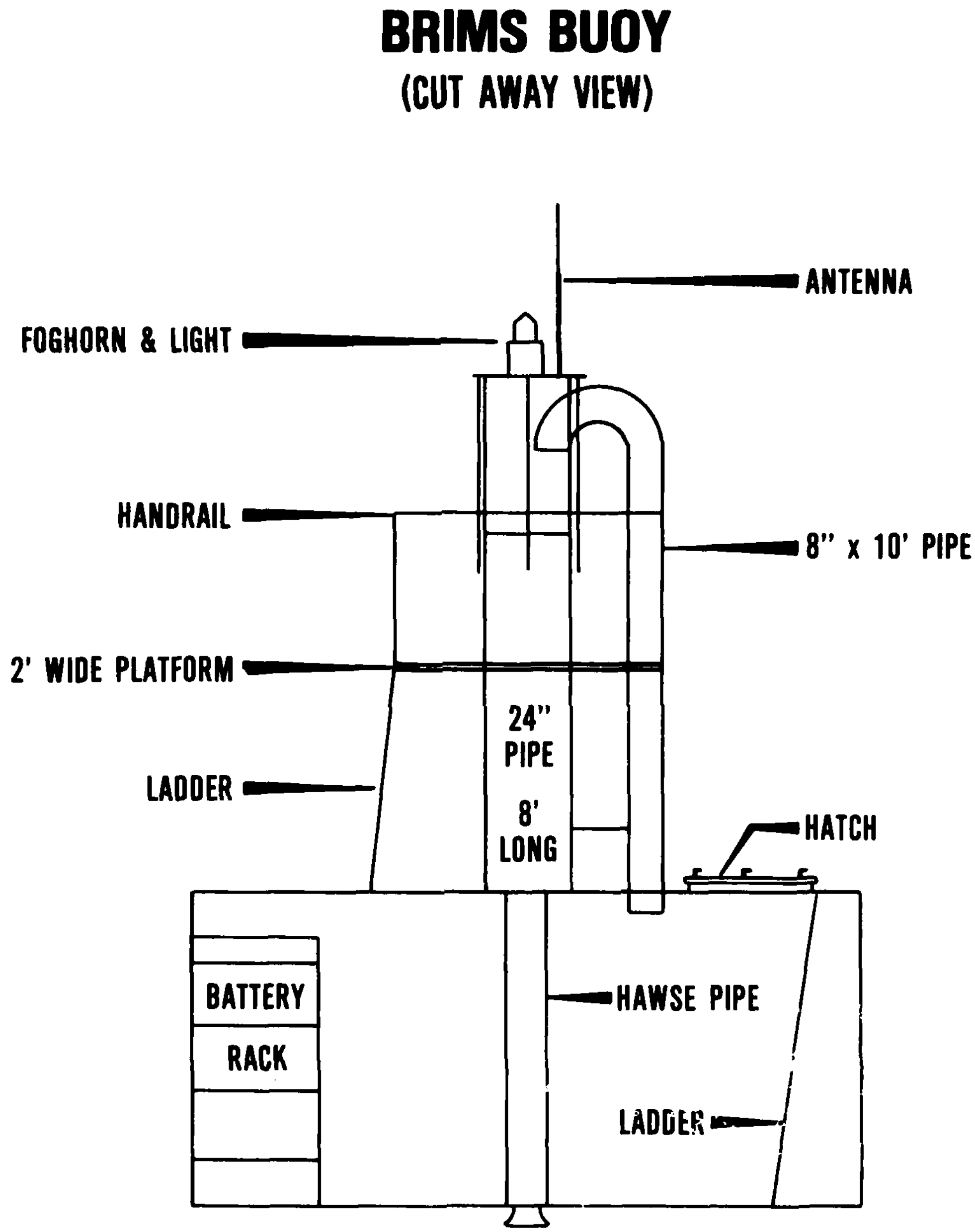

Figure 4. BRIMS Buoy General Arrangement

2.2.2 Anchor Legs

Anchor legs and joining hardware are shown in Figure 5. Each leg has been color coded and varies slightly in length as denoted below:

1. Yellow 581 ft
2. Red 547 ft
3. Black 550 ft

Figure 6 shows the placement of these legs.

Each shot of chain nominally weighs 3525 lbs. There are six shots per leg; hence, each leg has a chain weight of 21,150 lbs. The breaking strength of this chain is 322,000 lbs.

2.2.3 Anchors

The anchors for the BRIMS are 6000 lb STATO anchors. These anchors have a maximum holding power of 120,000 lbs.

For deployment, crown lines will be attached to the anchors to permit repositioning or retrieval, if necessary. Figure 7 shows crown line configuration.

3.0 IMPLANT SCHEDULE

Sep 13	Buoy and mooring gear depart NORDA
Sep 17	Gear arrives Galveston
Sep 17-23	House welded on buoy, batteries installed in buoy, USCGC BLACKTHORN rigged for deployment
Sep 24	Marker buoys for anchors and BRIMS buoy established
Sep 25-30	Mooring installation time frame
Oct 1-7	Contingency installation time frame

NOTE: USCGC BLACKTHORN will depart area on 8 Oct bound for 2 month yard period. Buoy must be moored prior to that time frame.

Oct 9	Sensors, cables and dry-end equipment departs NORDA
Oct 10-12	Sensors are staged and loaded aboard Schaeffer dive boat
Oct 13	Markers established for sensor positions
Oct 14-16	Lay cables, place sensors, route cables along chain
Oct 16-20	Jet cables into sea floor
Oct 21	Final inspection

4.0 BUOY AND ANCHOR LOCATION

4.1 BOAT AND NAVIGATION SET-UP

Schaeffer Diving Company, under contract to the Department of Energy will provide a diving boat and divers to assist in the installation of all marker buoys.

The boat will be outfitted with a NORDA-provided, LORAN-C navigation system. A navigation and charting team will be provided by NORDA. Marker buoys will be rigged in accordance with Figure 8.

ANCHOR LEGS

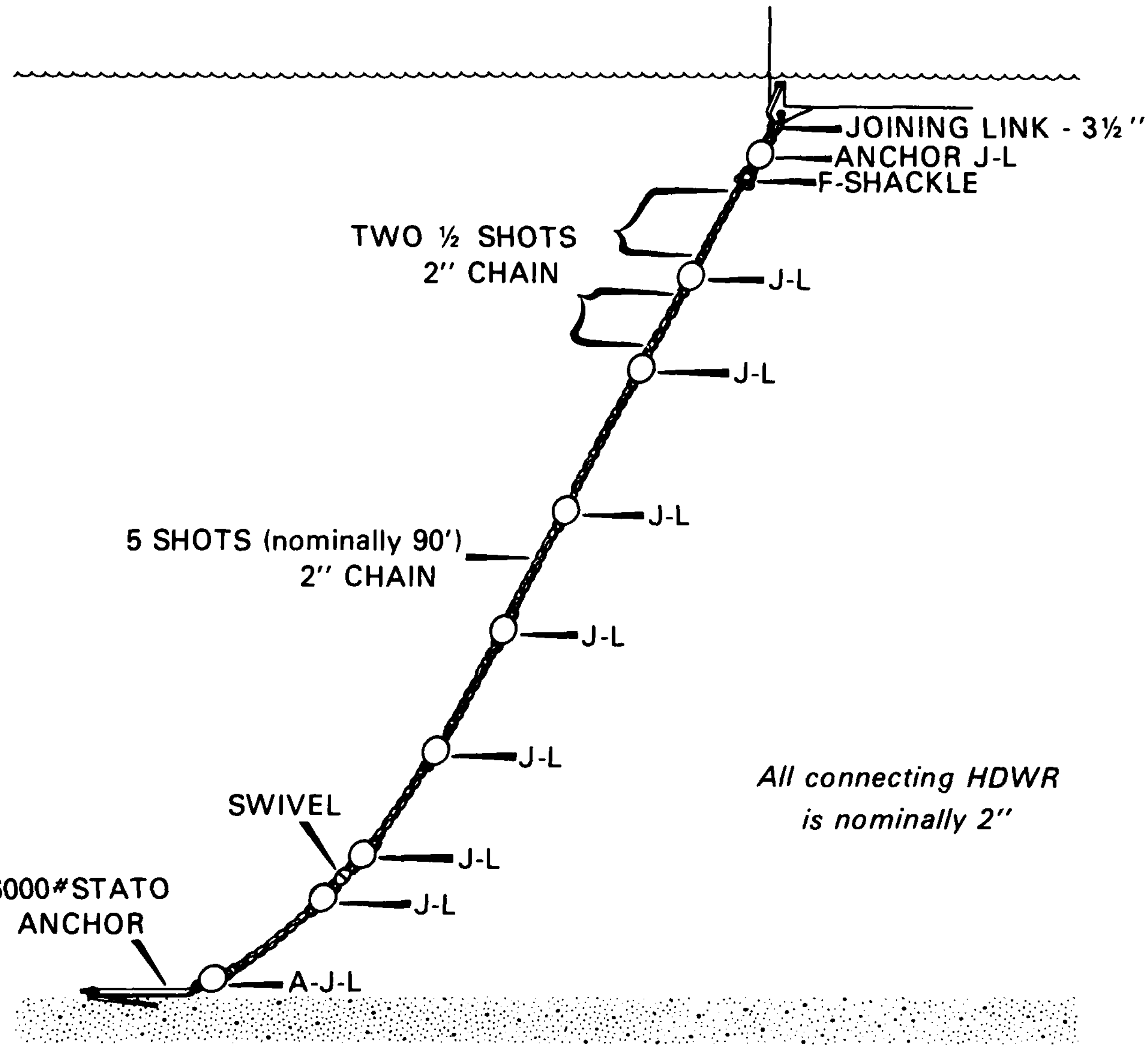

Figure 5. Typical Anchor Leg

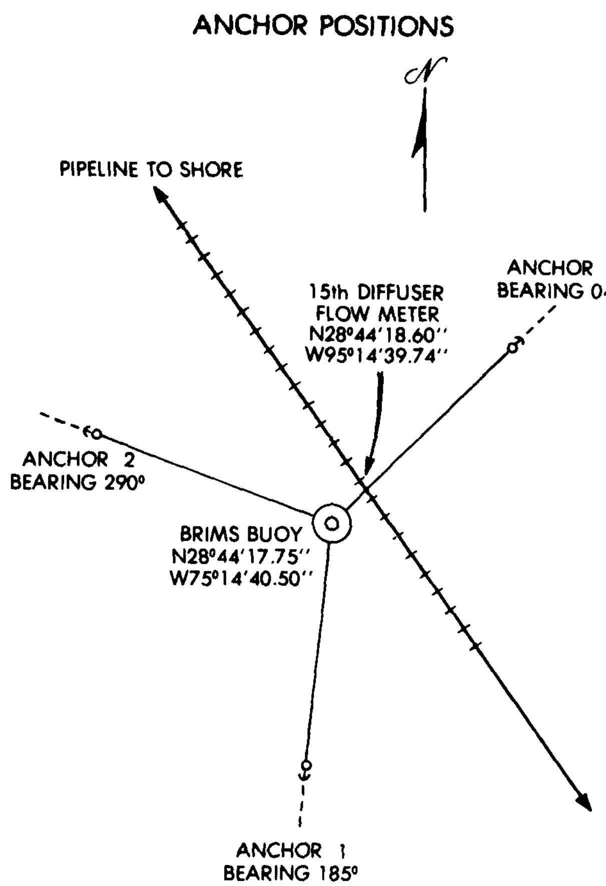

Figure 6. Anchor Positions

ANCHOR CROWN LINE

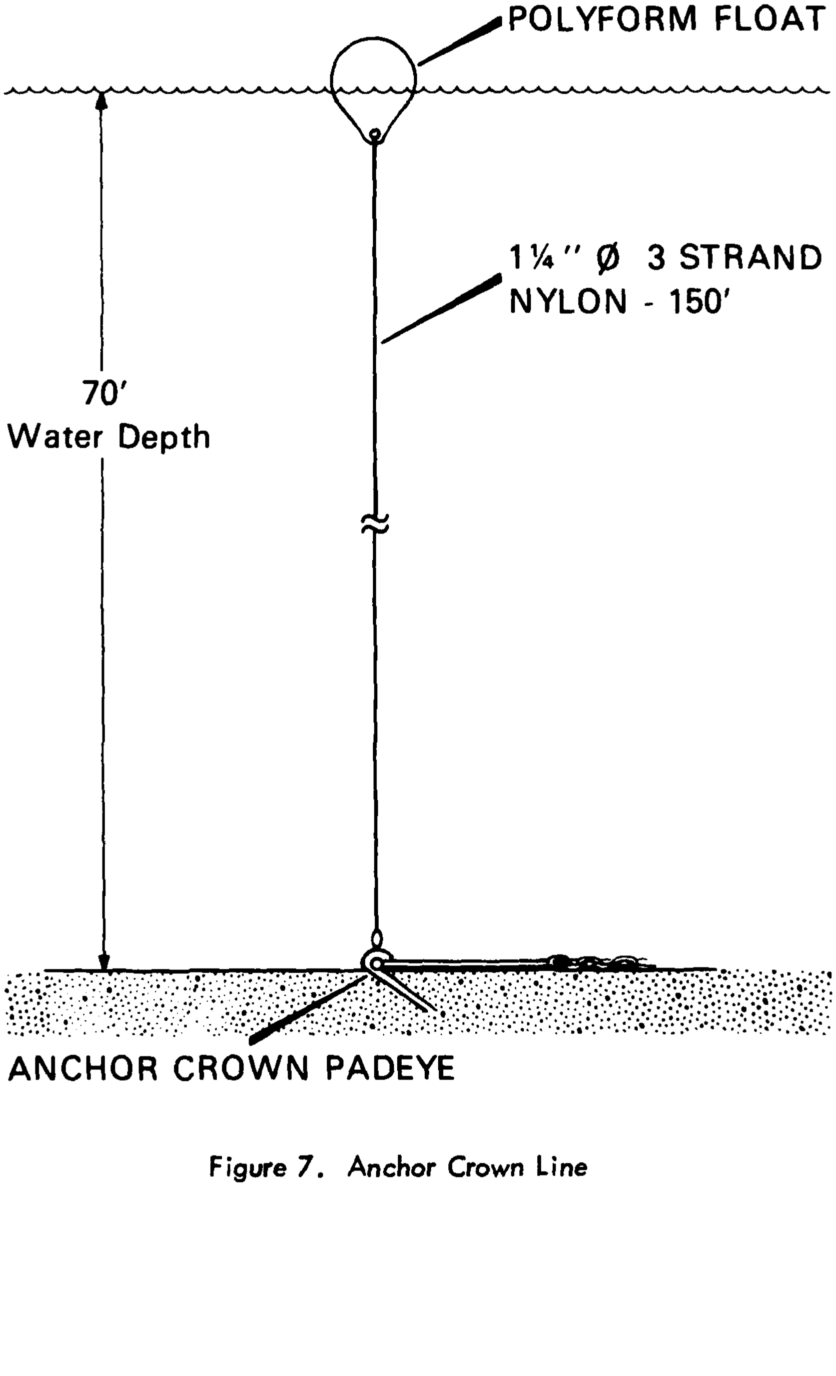

Figure 7. Anchor Crown Line

MARKER BUOYS

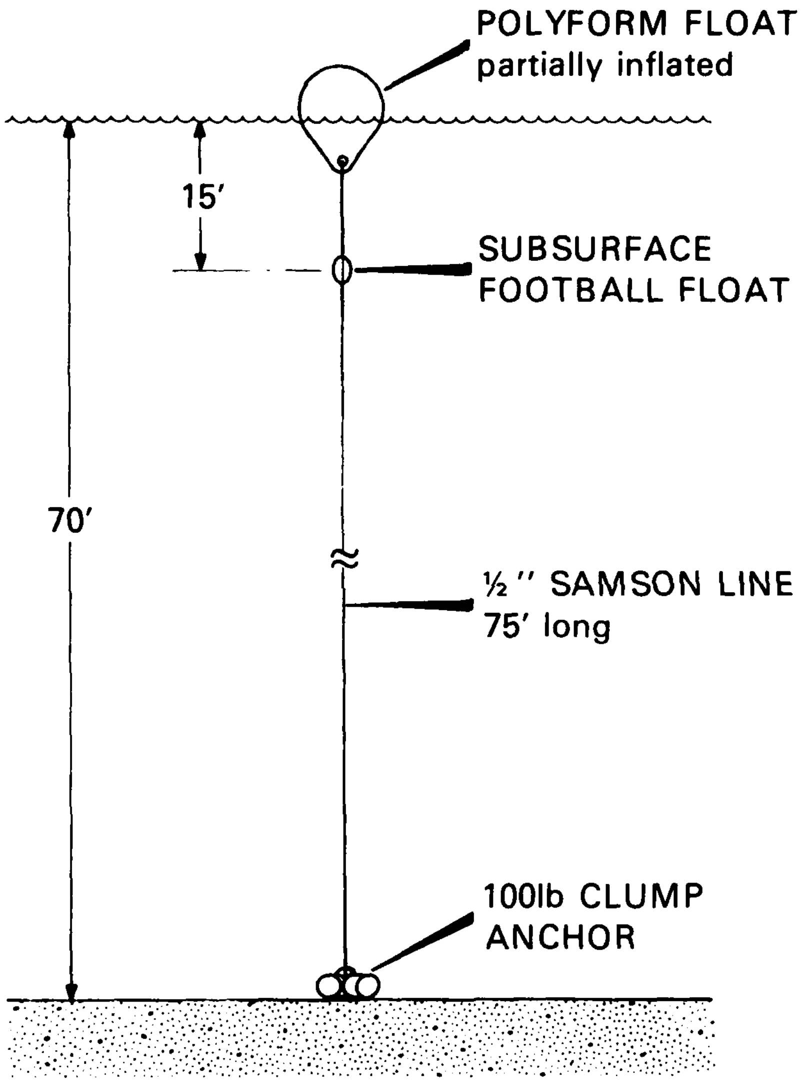

Figure 8. Marker Buoy Line

4.2 MARKER BUOY INSTALLATION

4.2.1 Mooring Buoy Marker

One day prior to the planned mooring buoy installation, the diving boat with LORAN-C, marker buoys, and divers aboard, will proceed to the site of the 15th diffuser port located at 28°44'18.606"N, 95°14'39.742"W. The diffuser is presently marked with a surface float. In the event that the surface float carries away or is otherwise missing, the port can be distinguished by divers by the following means: (1) A subsurface buoy is placed on the diffuser, (2) the check valve has been removed from the diffuser, and (3) the top of the cage surrounding the diffuser has two holes burned in it aligned with the axis of the pipeline (one hole on the shoreward side, the other on the seaward side).

Divers will descend on the diffuser port carrying with them a compass, a 100 ft distance line, and a small, temporary surface marker buoy and weight.

The divers will establish that they are on the 15th diffuser port and will mark a point 100 ft away from the diffuser, perpendicular to the axis of the pipeline on the western side of the pipe. There, they will place a temporary anchor weight and will pull up any slack in the temporary marker buoy line. The divers will surface and a marker buoy of the configuration of Figure 8 will be lowered next to the temporary marker. The divers will again descend on the site and will assure that the more permanent marker is in the correct position. They will then remove the temporary marker and will return to the surface.

The installed marker establishes the position of the mooring buoy.

4.2.2 Anchor Markers

When the mooring buoy marker position has been established, its position will be marked on a specially constructed LORAN-C chart (not included in this report). An overlay to this chart (also not included) has been prepared to denote anchor positions relative to the mooring buoy. From this overlay, the LORAN-C coordinates for the anchors may be obtained. Figure 6 shows the relative anchor/mooring buoy positions. Each leg extends a horizontal distance of 525 ft from the mooring buoy.

With the anchor positions established, the boat will proceed slowly to each anchor position, guided by the NORDA navigation team. Marker buoys will be faked out on deck for free running. Upon the word of the navigator, a marker buoy will be free-falled, anchor first, on the desired site. Each position will be rechecked after the marker buoy has stabilized. Divers will descend on each marker to assure no debris is in the area which would affect mooring anchor setting.

In the event that the LORAN-C malfunctions or is otherwise unsuitable, divers will utilize a compass and a 525 ft distance line to establish each marker point.

5.0 SHIPMENT PREPARATIONS, NORDA

Prior to shipment of equipment from NORDA, the buoy will be prerigged in the following manner: One half-shot (45 ft) of chain will be affixed to each of the three mooring padeyes. The other end of these shots will then be brought up to the top of the buoy. The chain will be cinched securely with synthetic line to the padeyes on the buoy top. Care will be taken to assure that the synthetic line will not chafe. The chain will be cinched at a point approximately 35 ft down from the bitter end, thereby providing 35 ft lazy pennants atop the buoy.

A 180 ft, 1-1/4 inch diameter nylon line, doubled, will be rigged to a top buoy padeye. This line will be used as a temporary moor line (as described in Chapter 7.9). Further shipment preparations include stowing all wet end instrumentation and equipment inside the buoy and plugging the 8 inch hole in the buoy top (hole accepts 8 inch gooseneck pipe). The house will be shipped separately from the buoy.

6.0 STAGING—GALVESTON

6.1 EQUIPMENT ARRIVAL

The mooring buoy, house, anchors, chain, markers, installation hardware, batteries and associated electronics equipment will arrive in Galveston via trucks on or about 17 September. All but the mooring buoy will be off-loaded at the USCG Station, Galveston. The buoy will be off-loaded into the harbor at the Galveston commercial wharves and towed to the Coast Guard Station by a Coast Guard vessel. The Coast Guard will provide a synthetic line towing hawser. The hawser will be attached to a 20 ft length of 1 inch diameter wire rope which will be reeved through one of the mooring padeyes on the bottom of the buoy prior to overboarding it. Once overboarded, the buoy will remain in the water. All subsequent work on the buoy will be done pierside with the buoy in the water.

All equipment will be temporarily staged at the buoy loading dock at the Coast Guard Station.

6.2 PREPARATION

The house will be welded on the buoy. Batteries will be mounted in the racks. The fog horn, light, antennas and weather vane will be mounted atop the house and wired and tested. All internal electronics equipment will be installed and checked out. The bilge pump plumbing will be installed and checked.

Two days prior to the planned installation day, all chains and anchors will be brought aboard the BLACKTHORN. Leg #1 (yellow) will be faked out on deck. A temporary mooring clump will be readied for overboarding.

6.3 DECK LAYOUT

The deck will be laid out as shown in Figure 9. Each anchor leg must be faked out separately due to limited buoy deck space (i.e., there is not enough room to fake out all three legs at once).

Leg #1 (yellow) will be faked out first.

The BLACKTHORN buoy deck will be loaded with the following equipment:

- 3 STATO anchors
- 3 Anchor Crown Lines and Buoys
- 3 Chain Legs (5-1/2 shots each) and all joining links (one leg faked out on deck, the other legs stored in four separate crates)
- 1 Coast Guard #8000 Mooring Clump
- 5 Pelican Hooks

The buoy will be rigged to be towed abaft of the BLACKTHORN. The opening in the 8 inch gooseneck will be sealed to prevent flooding in the unlikely event that the buoy capsizes during towing.

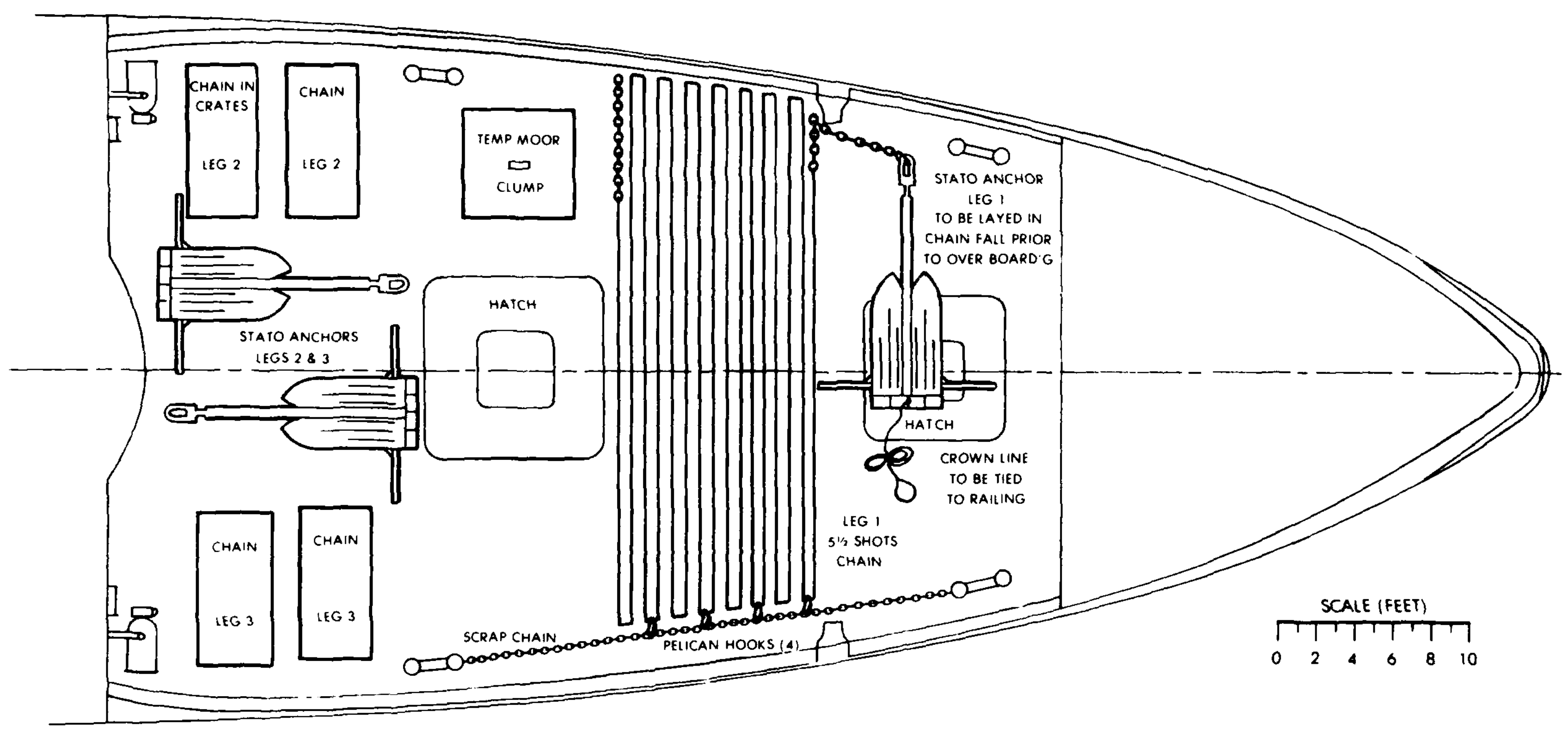

Figure 9. Deck Layout

The hawser used to tow the buoy will be rigged in the same manner as it was to bring it around from Galveston (Section 6.1).

7.0 BUOY MOORING OPERATIONS

7.1 TOW TO SITE

The implant site is nearly 50 miles from the Coast Guard base in Galveston; hence, at an expected tow speed of 4 knots, it would take 12-1/2 hours to get to site. (NOTE: Virtually no data exist on the tow characteristics of this buoy; hence, tow speed is essentially an engineering estimate. If time permits, during the tow of the buoy around from the Galveston wharves to the Coast Guard Station, different tow speeds will be tried to assess buoy performance. If the buoy seems to have a tendency to kite back and forth in the wake, the two 1/2 shots of chain on the buoy that face aft may be lowered further to provide a drag stabilization.)

To allow for a 12-1/2 hour tow, the BLACKTHORN must depart Galveston on or about 1800 hours to permit arrival on site at first light.

A tow watch will be posted throughout the tow.

The BLACKTHORN will depart only when good weather, i.e., sea state three or less, is predicted for period in excess of 36 hours.

7.2 TEMPORARY MOORING

Once at the site,the BRIMS buoy will be maneuvered alongside the port buoy deck and secured to a position aft of the temporary mooring clump (see Fig. 9 for clump position). The temporary mooring line (described in 5.0) will be attached to the mooring clump. The BLACKTHORN will maneuver to the buoy marker. The BRIMS buoy will be set free of the BLACKTHORN and the clump will be over-boarded. This will place the buoy in a stable, temporary moor.

7.3 ANCHOR LEG INSTALLATION

With the BRIMS buoy in a temporary moor, the BLACKTHORN buoy deck will be readied for deploying anchor leg #1. The STATO anchor will be hung over the side, attached to the ship's chain stopper. The anchor crown line will be tied off to the railing in bights. Any chain which had shifted during transit will be repositioned. All chain fittings will be rechecked.

The BLACKTHORN will then reposition next to the BRIMS buoy. The BLACKTHORN boom will pick up the bitter end of the nearest half shot of chain attached to the buoy. A rigger will be on-board the BRIMS buoy and will cut the synthetic chain cinch line when the boom has the full chain load. The chain will be brought aboard the BLACKTHORN buoy deck and will be affixed to the bitter end of the remaining chain of leg #1 faked out on deck.

The BLACKTHORN will then proceed toward the marker buoy for leg #1. Pelican hooks shown on Figure 9 will be released sequentially. No more than one shot of chain will be dropped at any one time. The chain will be stretched out prior to the release of each pelican hook.

In a like manner, legs #2 and #3 will be faked out on deck and installed. The BLACKTHORN will return to the BRIMS buoy. A swimmer will cut the temporary mooring line, and the mooring clump will be abandoned.

The anchors may be repositioned, if necessary, by heaving on the crown lines. When the anchors are in position, the crown buoys will be removed, a small weight will be attached to the crown line end. The line and weight will be pulled in a direction away from the buoy and overboarded.

This concludes the BRIMS buoy installation. The BLACKTHORN will then return to base.

8.0 DIVER OPERATIONS

Diver operations will be conducted by Schaeffer Diving Company, Freeport, Texas, under contract to the Department of Energy. The diving support vessel is a 105 ft work boat, the M/V ROCKET III. The M/V ROCKET, in addition to being a diving support boat, has a U-frame with a 50-ton lift capacity.

8.1 INSPECTION/PREPARATION

Divers will proceed to the BRIMS site and, under the technical guidance of the NORDA representative, will inspect the mooring configuration. Each leg will be swum and inspected to determine that it is straight, that the chain follows a smooth catenary with no piles of loose chain, and that the anchor flukes are deployed or ready to deploy when loaded. If the legs need straightening or anchors need repositioning, the crown lines will be brought back to the surface by the divers and the M/V ROCKET will reposition as necessary. When the legs are in the proper position, the crown lines will be cut loose and brought aboard the ROCKET. Other clean up will include removal of the temporary mooring line. The temporary mooring clump will not be removed unless it in some way would affect the permanent mooring, the brine pipeline, or sensor/cable performances.

8.2 MARKER BUOY PLACEMENT

Marker buoys for sensor positions will be deployed using the NORDA-provided, LORAN-C for navigation. Procedures and equipment are identical to that described in Chapter 4.2.2.

It is expected that diver inspection/preparation and marker buoy placement will be done in one day.

8.3 CABLE LAYING/SENSOR PLACEMENT

All cables, sensors, grips, and lowering lines will be loaded aboard the ROCKET.

The ROCKET will proceed to site and tie up to the BRIMS buoy.

Two NORDA representatives will board the BRIMS buoy. A weighted line will be threaded down through the house and hawse pipe. A diver will bring the end of the weighted line out from under the buoy and back to the surface. There it will be tied back into its other end, thus providing a loop through the buoy hawse and around the outside of the buoy. This "feeder loop" will be used to pull up the bitter ends of the signal cables through the hawse and house.

8.3.1 Flow Meter Installation

The first meter to be installed will be the flow meter. The M/V ROCKET will be tied alongside the BRIMS buoy. The flow meter cable will be faked out on the deck of the ROCKET in a figure eight. A diver will enter the water and will secure the bitter end of the sensor cable to the feeder loop. The cable will be pulled aboard the buoy and fed down through the gooseneck. Approximately 150 ft of cable will be brought aboard the buoy.

The remaining cable (approx. 170 ft) aboard the ROCKET will be lowered in a bight to the bottom. Divers will descend with the sensor mounted in the modified discharge hose, Figure 10. They will then mount the sensor in the 15th diffuser port, assuring that the sensor probe is properly aligned with the direction of flow in the pipe. To assist in this alignment, a prominent white stripe will be painted on the discharge hose. This stripe must face toward the shore along the axis of the brine line.

A 25 lb syntactic foam float will have been installed on the cable approximately 40 ft from the flow sensor.

Divers will attach Kevlar Seamans stoppers from the chain of leg #3 to the sensor cable strength member at two points shown in Figure 11.

Final adjustments in the amount of cable slack required at the buoy will be made. Personnel aboard the buoy will then attach a Seamans stopper to the cable and secure it to a tie-off point just below the gooseneck on the buoy house.

During installation, personnel aboard the BRIMS buoy will monitor the sensor to assure that it is working. They will be in contact with the ROCKET via Motorola handi-talkies.

8.3.2 Current Meter Installation

The ROCKET will tie up to the BRIMS buoy on the eastern side (if not already there).

The current meter sensor cable (492 ft long) will be faked out in a figure eight on the ROCKET deck. The meter and stand will be on the bottom of the cable pile with a lowering line attached. The lowering line will have a small float on its bitter end.

As done in the flow meter installation, a diver will attach the bitter end of the sensor cable to the feeder line under the buoy. The cable will be brought up through the hawse and the house and fed into the gooseneck. It will then be secured with a Seamans stopper at the top of the buoy house.

The diver will then begin to attach the cable to chain leg #3 with Seamans stoppers spaced approximately every 100 ft. He must assure that the cable catenary is greater than that of the chain as shown in Figure 1. He must be particularly sure that the cable is quite slack between the buoy hawse and the first stopper.

The diver will be surface tethered and will have communications with the surface. Cable will be payed out by hand from the surface upon the diver's command. The last stopper will be placed on the cable at a point where the chain is approximately five feet above the sea floor.

The diver will then return to the surface, and the ROCKET will proceed along a generally parallel path to leg #3 and slightly to the south. Sensor cable will be payed out by hand. At the end of the cable run, the sensor and stand will be lowered by the lowering line. The lowering line and buoy will then be cast off.

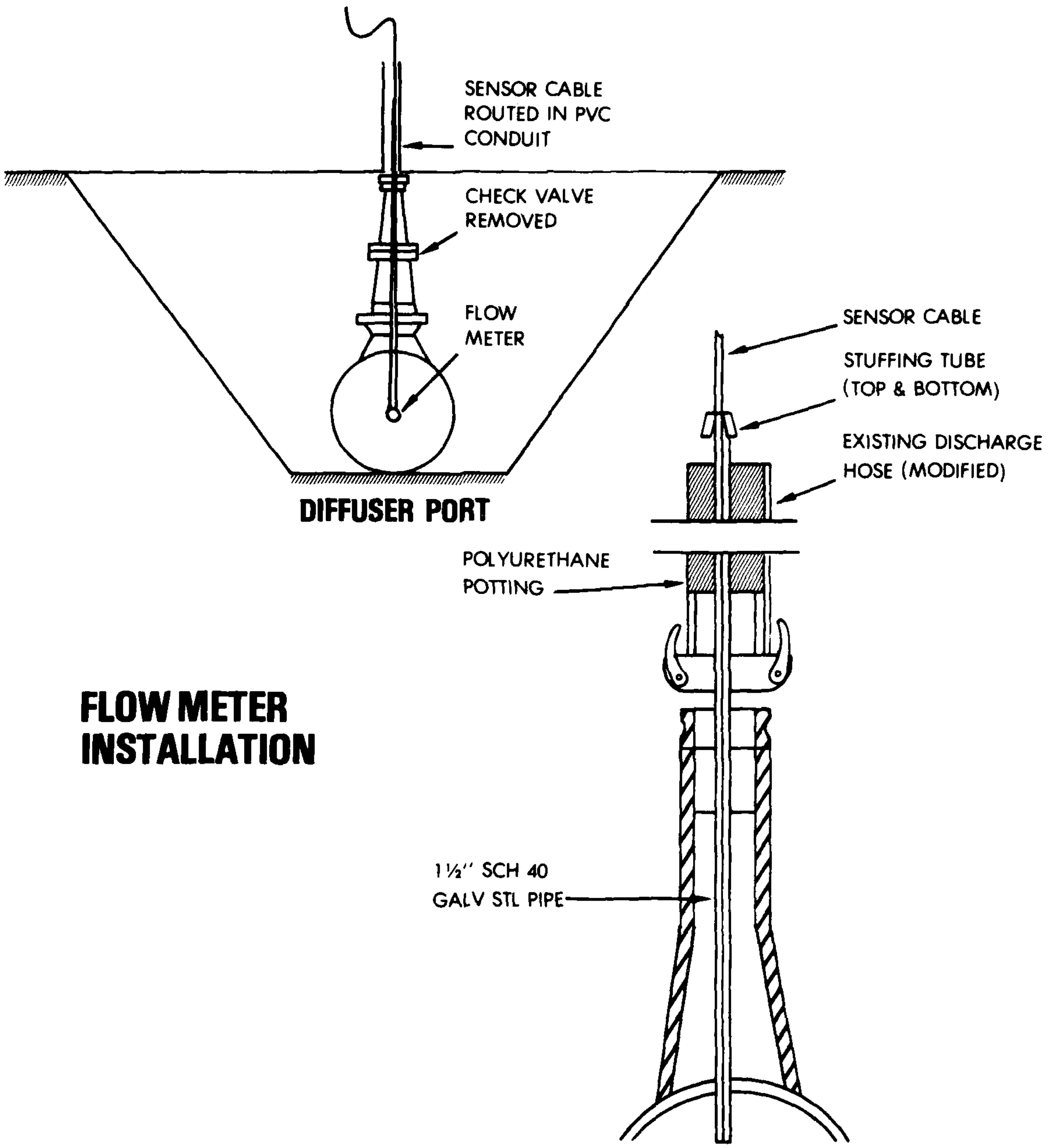

Figure 10. Flow Meter Installation

FLOW METER INSTALLATION

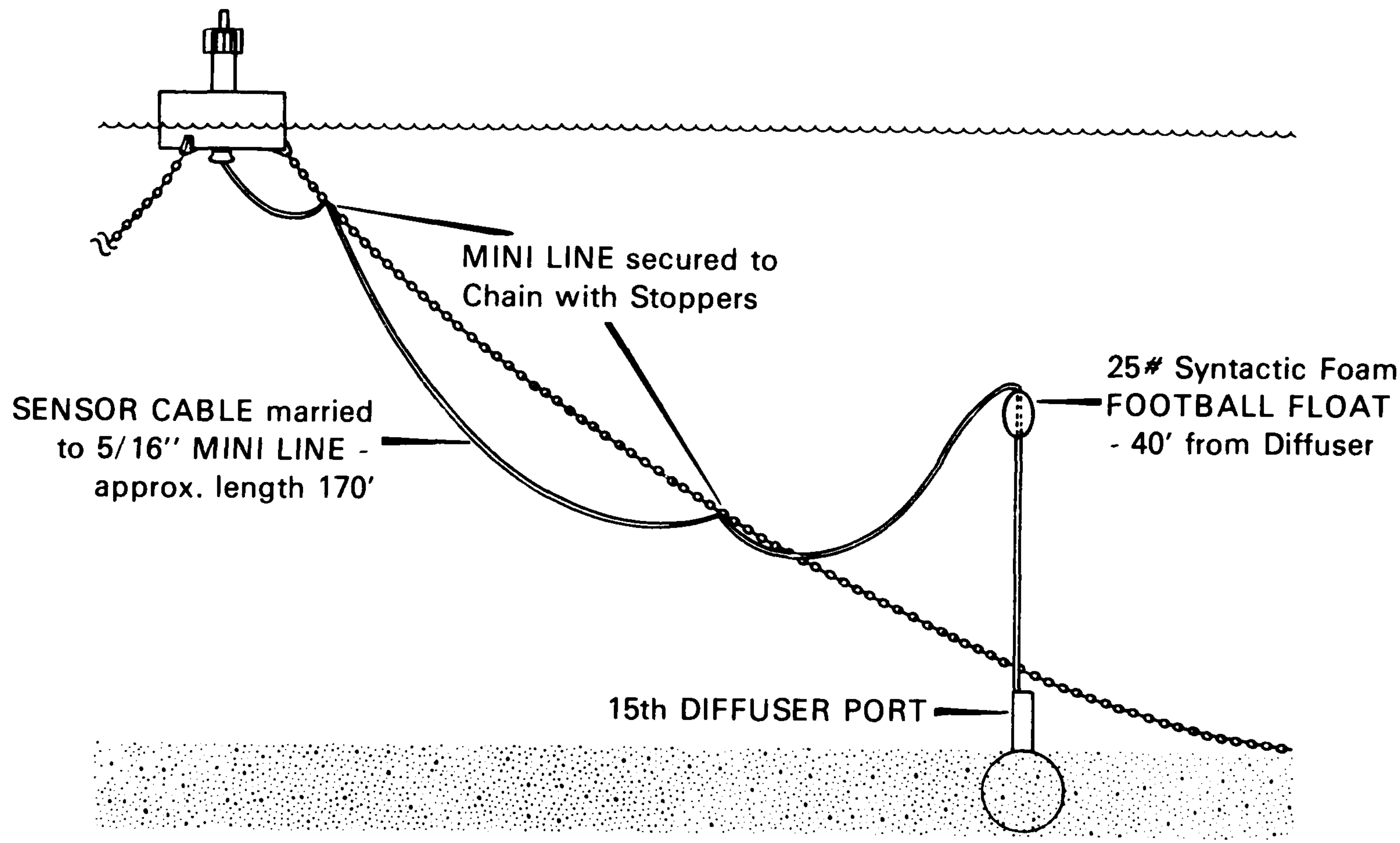

Figure II. Flow Meter Installation

Divers will descend on the lowering line, carrying with them an accurate compass board.

The divers will swim the sensor cable to assure that it does not cross the chain of leg #3. They will also assure that the stand itself is at least 30 ft south of the chain. Divers will then orient the sensor.

The sensor stand shown in Figure 12 will have a prominent arrow marked on it. Using the compass board, the stand will be oriented so that the arrow points 6° to the west of north (354°). This will align the meter with true north.

The divers will then pull the marker buoy line until it is taut, and the ROCKET will obtain an accurate LORAN-C of that position for future reference.

NORDA personnel aboard the buoy will monitor sensor performance during the entire implantment.

8.3.3 Conductivity-Temperature Sensor Installation

Placement of the conductivity-temperature (C-T) sensor will proceed in a manner nearly identical to that of the current meter. Two major differences are: (1) the sensor cable is steel armored; hence, preformed line grips will be used instead of Seamans stoppers at all tie-off points, and (2) no alignment of the sensors (other than assuring they are vertical) is required.

Figure 3 shows the positions and lengths of cable for each of the four C-T sensors.

Figure 13 shows the configuration of the C-T sensor mooring.

9.0 FINAL INSPECTION

The senior NORDA Representative will conduct a diver inspection at the completion of each diving day or as often as feasible.

CURRENT METER STAND

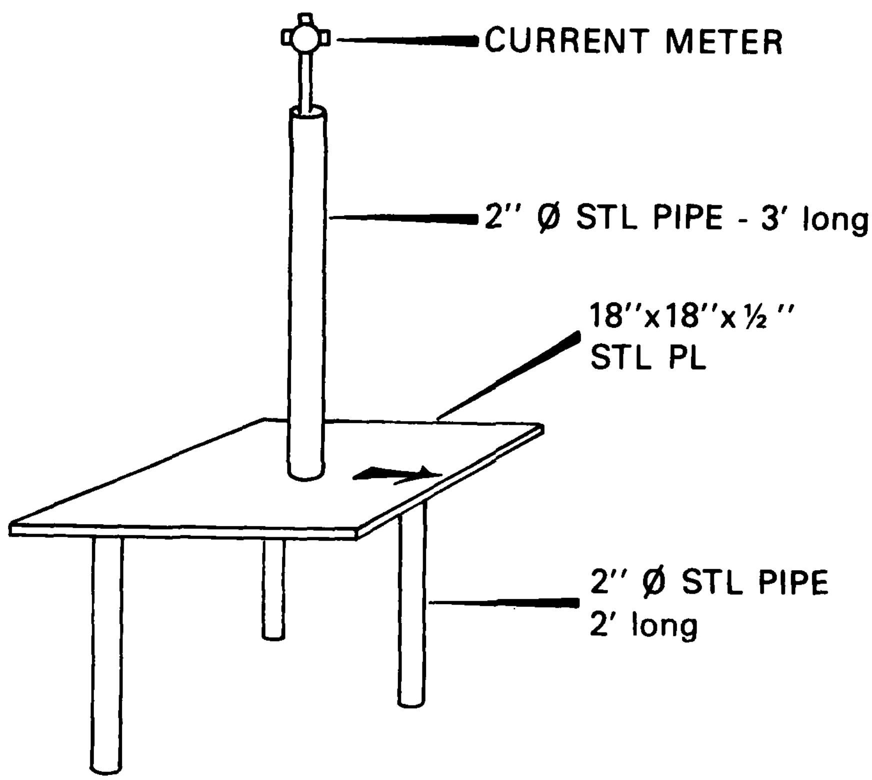

Figure 12. Current Meter Stand

C-T METER STAND

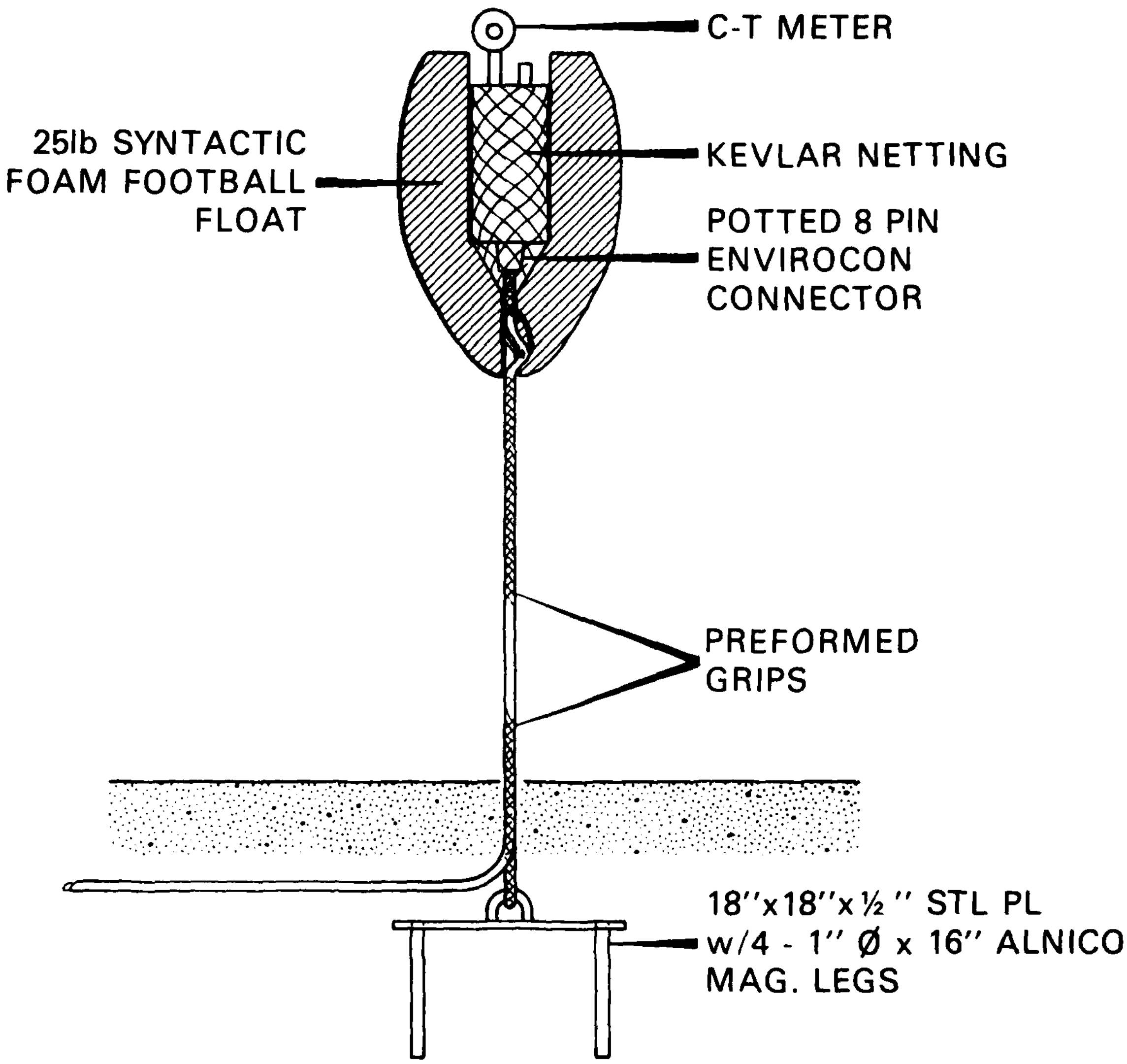

Figure 13. Conductivity Temperature Sensor Mount

APPENDICES

I. Moor Components

II. Moor Installation Equipment

III. Sensor/Cable Components

IV. Sensor Installation Equipment

APPENDIX I

Moor Components

1.	Buoy and House	1 Ea
2.	Chain (2 inch)	15 Shots
3.	Chain (2 inch)	6 Half Shots
4.	Anchor Joining Links (2-1/4 inch)	6 Ea
5.	F-Shackles (2-1/4 inch)	3 Ea
6.	Swivels (2-1/4 inch)	3 Ea
7.	Joining Links (3-1/2 inch)	3 Ea
8.	Joining Links (2 to 2-1/4 inch)	21 Ea
9.	STATO Anchors (6000 lb)	3 Ea
10.	Lead	LS
11.	Batteries and Electronics	LS
12.	Fog Horn, Light	1 Ea
13.	Antennas	LS
14.	Anemometer/Stand	1 Ea

APPENDIX II

Moor Installation Equipment

1.	Charts	LS
2.	Crown Lines	
	A. Polyforms	3 Ea
	B. 1-1/4 inch Nylon-150 ft	3 Ea
	C. Shackles (to anchor crown)	3 Ea
3.	Micrologic LORAN-C Navigator	1 Ea
4.	Marker Buoys	
	A. Polyforms	4 Ea
	B. 10 lb Football Floats	4 Ea
	C. 1/2 inch Samson-75 ft	4 Ea
	D. 100 lb Clumps	4 Ea
5.	Plotting/Charting Instruments	LS
6.	Diving Equipment (1 person)	LS
7.	Compass Board	1 Ea
8.	100 ft Distance Line, 525 ft Distance Line	1 Ea
9.	Small Buoy, Line, Weight	1 Ea
10.	Cinch Ropes	3 Ea
11.	Temp. Moor Line (1-1/4 inch x 180 ft)	1 Ea
12.	Pelican Hooks	5 Ea
13.	Gooseneck Plug	1 Ea
14.	Temporary Mooring Clump	1 Ea
15.	Buoy Lifting Slings (1 inch x 20 ft W.R.)	3 Ea
16.	Tow Sling (1 inch x 20 ft W.R.)	1 Ea
17.	Tow Hawser	1 Ea
18.	Small Weights (for crown line)	3 Ea

APPENDIX III

Sensor/Cable Components

1.	Flow Meter	
	A. Sensor in Housing	1 Ea
	B. Cable (328 ft) Married to 200 ft Miniline	1 Ea
	C. Kevlar Stoppers	4 Ea
	D. 25 lb Football Floats	1 Ea
2.	Current Meter	
	A. Meter	1 Ea
	B. Cable	492 ft
	C. Stoppers	6 Ea
	D. Stand	1 Ea
3.	C-T Meter	
	A. Meters	4 Ea
	B. 25 lb Floats bored out	4 Ea
	C. Kev Netting	4 Ea
	D. Preformed Grips	20 Ea
	E. Anchor Plates	4 Ea
	F. Magnets	16 Ea
4.	C-T Sensor Cables	
	A. 1850 ft (w/potted connector)	1 Ea
	B. 1800 ft (w/potted connector)	1 Ea
	C. 1800 ft (w/potted connector)	1 Ea
	D. 1350 ft (w/potted connector)	1 Ea

APPENDIX IV

Sensor Installation Equipment

1.	Charts	LS
2.	Micrologic LORAN-C	1 Ea
3.	Marker Buoys	
	A. Polyforms	4 Ea
	B. 10 lb Football Floats	4 Ea
	C. 1/2 inch Samson-75 ft	4 Ea
	D. 100 lb Clumps	4 Ea
4.	Plotting Chart Instruments	LS
5.	Diving Equipment	LS
6.	Compass Board	1 Ea
7.	1/2 inch x 60 ft Feeder Line	1 Ea
8.	Motorola. Handi Talkies	3 Ea
9.	Lowering Lines 1/2 inch x 80 ft	5 Ea
10.	Buoys (small)	5 Ea
11.	Water Jet Equipment	LS

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The Brine Measurement System (BRIMS) was designed and developed by the Naval Ocean Research and Development Activity (NORDA), Code 350, in support of the Department of Energy, Strategic Petroleum Reserve's requirement to expel brine from a salt dome for subsequent oil storage. BRIMS consists of a buoyed platform which telemeters, to shore, data gathered by an array of oceanographic and meteorological sensors which measure and quantify the dispersion of the brine solution emanating from a pipeline ending 12.5 miles at sea in the Gulf of Mexico. (CONTINUED)

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The BRIMS buoy and mooring spread consists of a large 10.5 ton cylindrical buoy and three chain/anchor mooring legs, each consisting of 13.5 tons of hardware. Emanating from the buoy are a series of cables which transmit data from underwater sensors.

This report details the operational planning necessary to effectively and efficiently implant a system of this magnitude and complexity.

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